Vending Machine Monitoring System

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Team Members:
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Introduction

- Problem:
  - Maintaining vending machine inventory
    - Wireless communication is expensive
    - Too much time to personally check machines
- Desired Solution:
  - Cheaper alternative to wireless communication
  - Improve maintenance efficiency

Introduction

- Device reads status information from vending machine controller (DEX)
- Proposed device alerts consumer with LCD message to call a database to enter encrypted code
- Consumer receives new code and free beverage

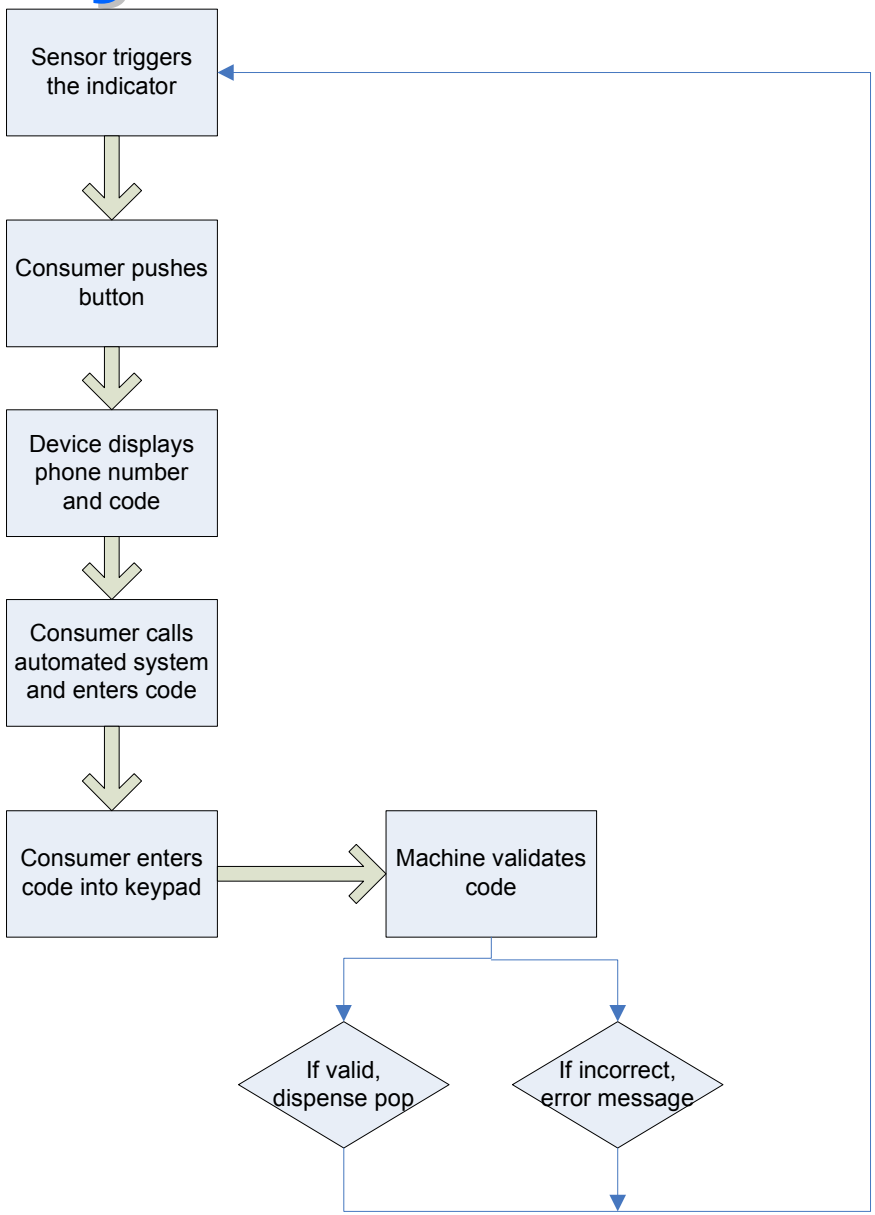
Requirements

- Information from DEX:
  - Inventory of each product
  - Amount of bills, coins
  - Location / identification of machine
- Unique encrypted codes
- Triggers only once until re-serviced

Requirements Cont'd

- Encryption / Decryption keys provided to company
- 16 digit code
- Components to fit inside machine
- LCD, button, and keypad placed outside machine
- Client would prefer C# language for software

Project Flow Chart

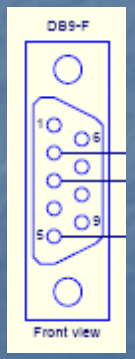


Technical Content

- Peter: DEX
- Birendra: Encryption / Decryption
- Shannon: Hardware / Code

DEX

- Serial Communication (RS-232)
- Using serial communication interrupts
- Made Cable (schematic below) for transfer



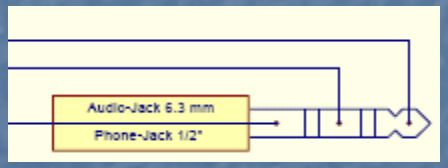


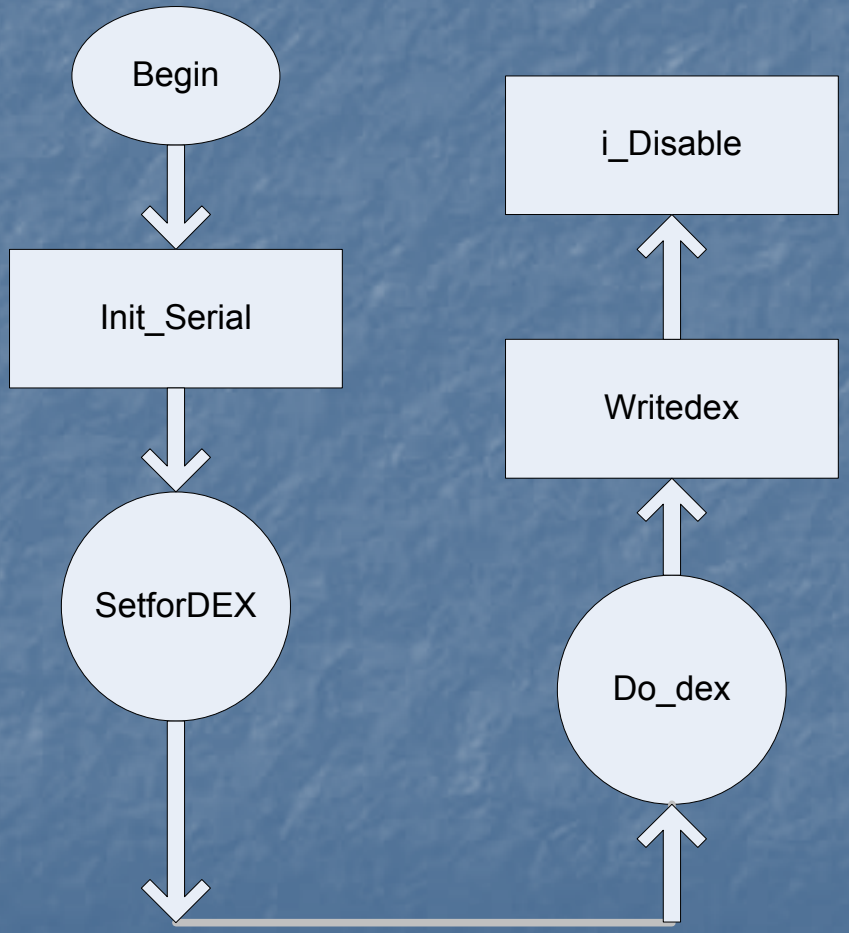
Diagram Provided
by Bonusdata.net

DEX information

- DEX raw data provides the following information:
  - Machine serial number
  - Sales summary
    - Overall or per product
  - Money Contained (Coins, Bills)
  - Item sold out
  - Other information
    - Power outage counter, number of DEX reads

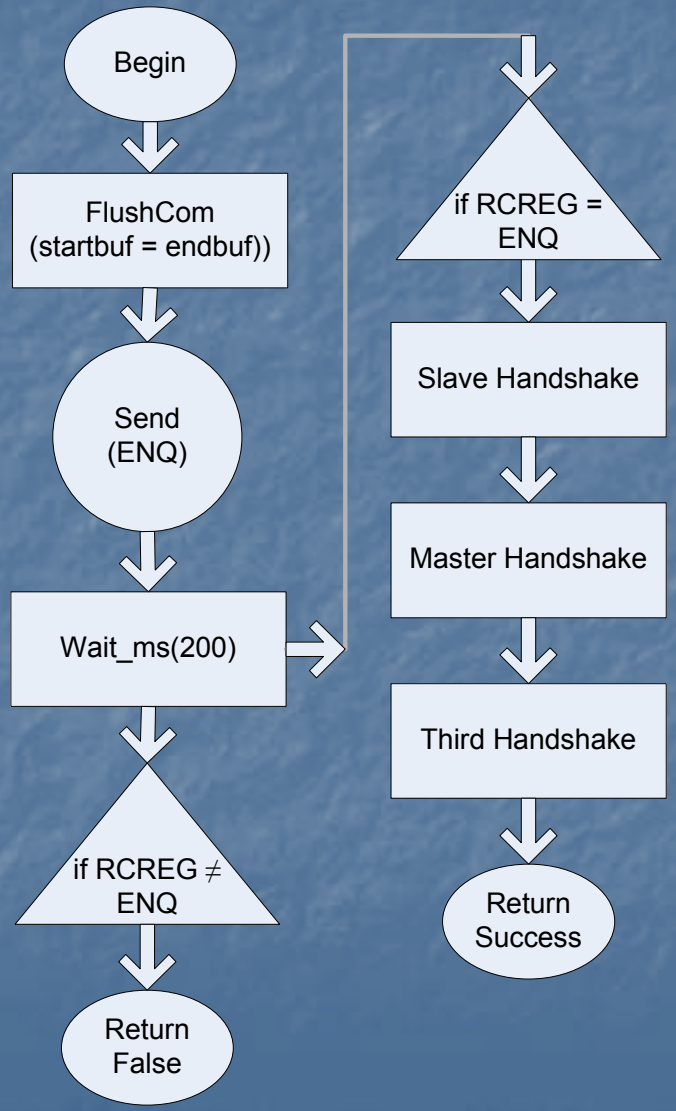
DEX Main Flow Chart

Main Program



DEX Communication Flow Chart

Handshaking functions set master and slave, while third handshake stores DEX raw data into an array



DEX Serial Communication

- Using RC6 and RC7 from PIC as transmit and receive lines
- TXREG and RCREG commands to send and transmit data
  - Send ENQ, receive using RCREG
- Set baud rate – must match

DEX Summary

- Serial Communication (RS-232)
- Check status after each vend
- Trigger beverage vend
- Can provide which items are sold out
- Our customer would like the capability to provide inventory
  - DEX does not directly provide inventory
  - Counter reset each time machine filled could solve this

Inventory Status Message

- Get information from DEX
- DEXINFO

3	9	6	7	7	7	1	0	12	1	10	2	4	15	21	0	9	1	0	4

Serial No. Product Inventory Coins/Bills

- Store inventory of each product in INV[7]

INV	12	1	10	2	4	15	21

- Check if product running low and store status in PID[7]

PID	0	1	0	1	1	0	1

- Check if coins and bills are running low or overflowing

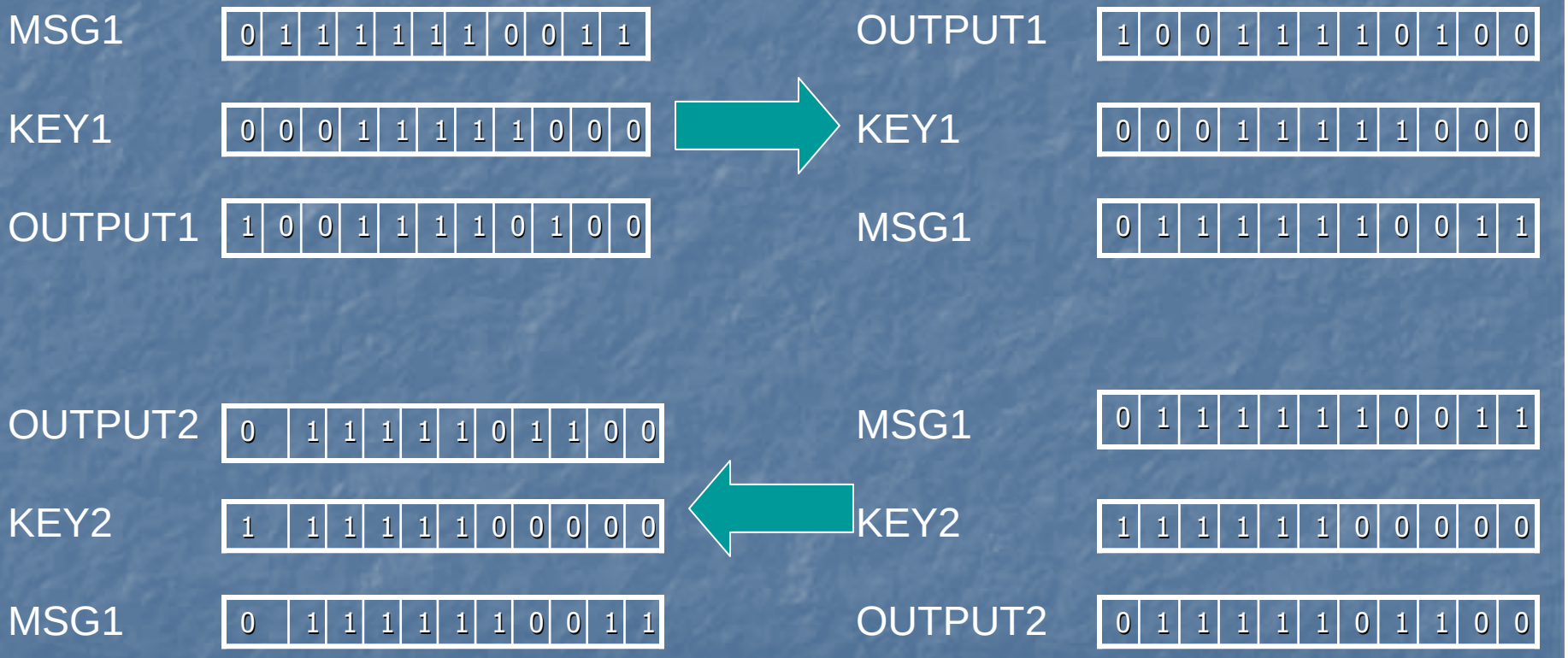
Inventory Status Message(Contd.)

- InvEmergency=1
  - ✓ product running low
  - ✓ too many/few coins/bills
- Encrypt

Algorithm

VENDING MACHINE

APPOLIS



Implementing the Algorithm

- Encrypt converted into binary (BinEncrypt)
- XOR with KEY1 -> EncryptedInfo
- EncryptedInfo converted into dec (DecEncrypt)
- Displayed on LCD to send to Appolis

BinEncrypt	0	1	1	1	1	1	1	0	0	1	1
KEY1	0	0	0	1	1	1	1	1	0	0	0
EncryptedInfo	1	0	0	1	1	1	1	0	1	0	0

Implementing the Algorithm(Contd.)

- Software receives DecEncrypt
- Convert into binary
- XOR with KEY1 and extract original msg

BinDecrypt	1 0 0 1 1 1 1 0 1 0 0
KEY1	0 0 0 1 1 1 1 1 0 0 0
Original Msg	0 1 1 1 1 1 1 0 0 1 1

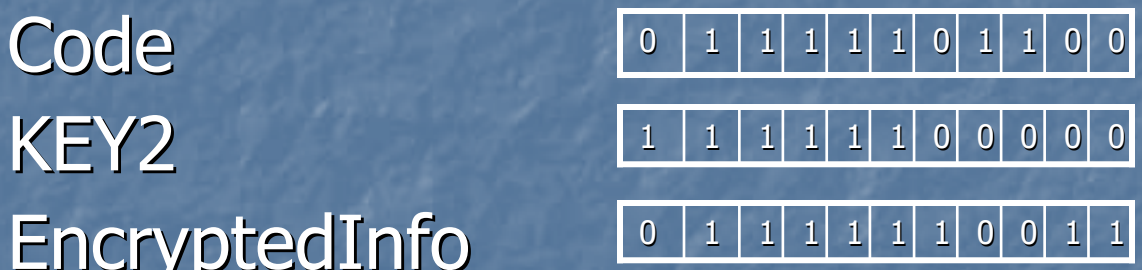
Implementing the Algorithm(Contd.)

- OriginalMsg XOR with KEY2 -> Code
- Convert into dec and send it to user

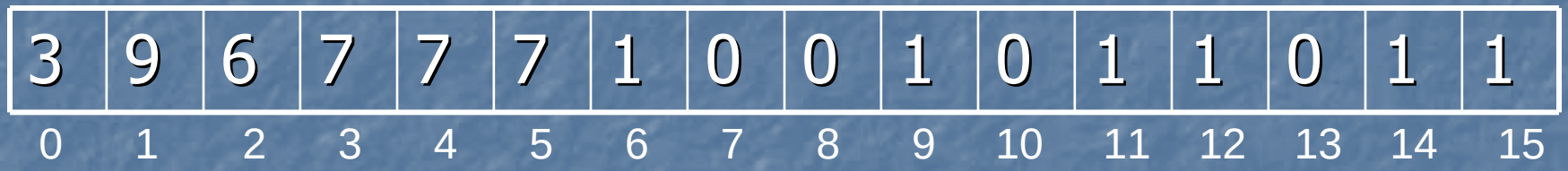
OrgMsg	0	1	1	1	1	1	1	0	0	1	1
KEY2	1	1	1	1	1	1	0	0	0	0	0
Code	0	1	1	1	1	1	0	1	1	0	0

Implementing the Algorithm(Contd.)

- User enters Code
- Code converted into binary
- XOR with KEY2 -> EncryptedInfo
- This validates the code
- Free Pop dispensed!



Decrypting the Message

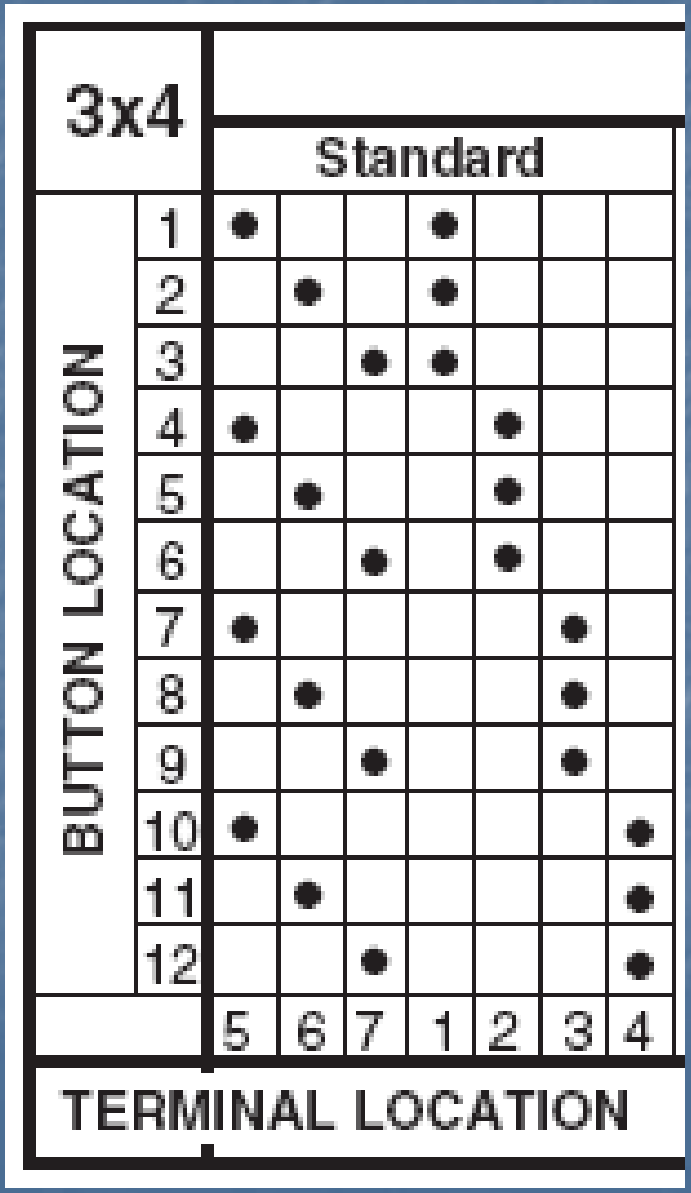


- Serial No 0-7 Identify/locate the vending machine
- PID 8-14 Indicates which products are running low
- Coins/Bills 15 Indicates coin/bill emergency

Hardware / Software

- Keypad
- Button
- LED’s
- Interface with LCD

Keypad

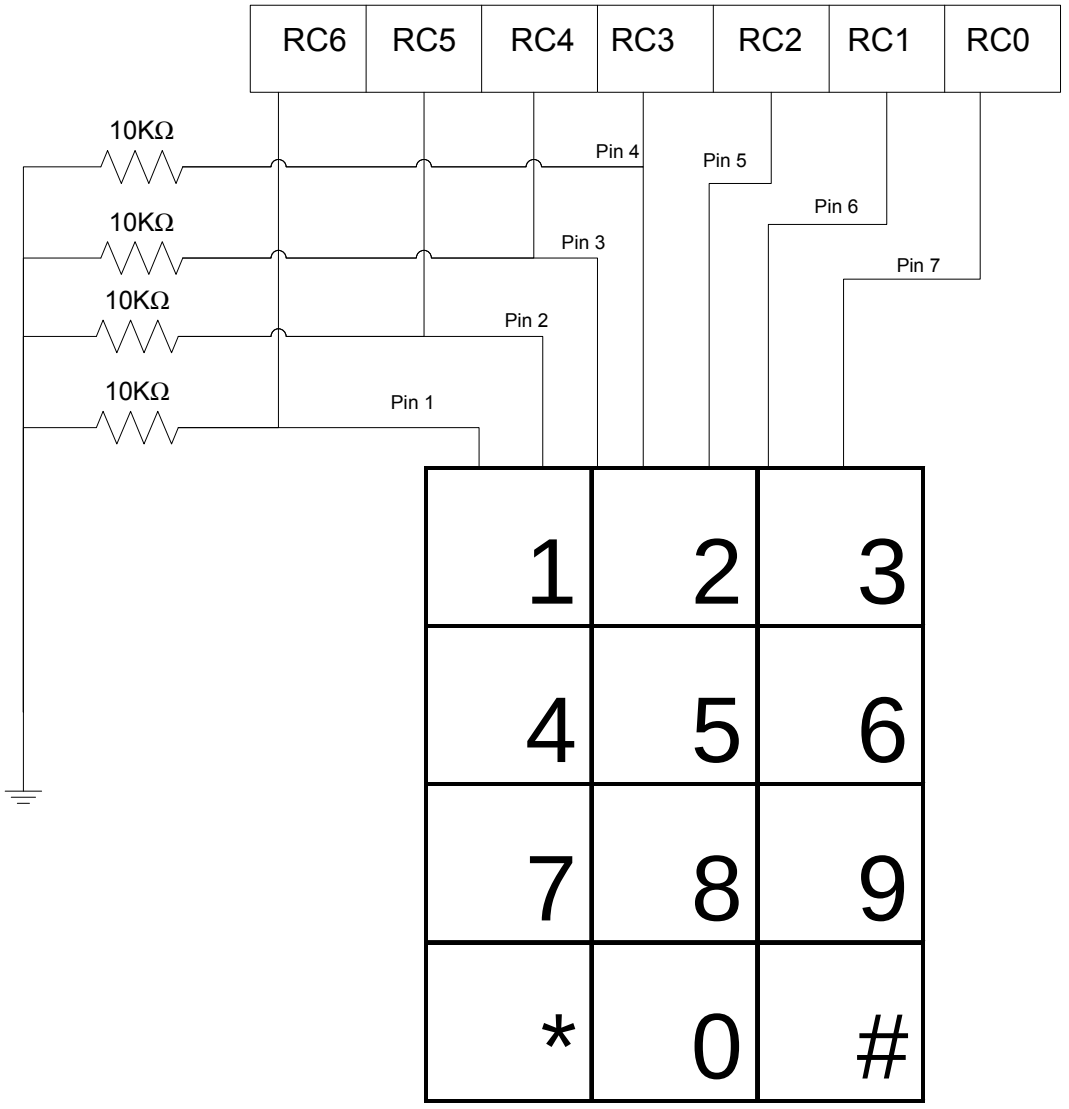


Pin 5 ↓	Pin 6 ↓	Pin 7 ↓	
1	2	3	← Pin 1
4	5	6	← Pin 2
7	8	9	← Pin 3
*	0	#	← Pin 4

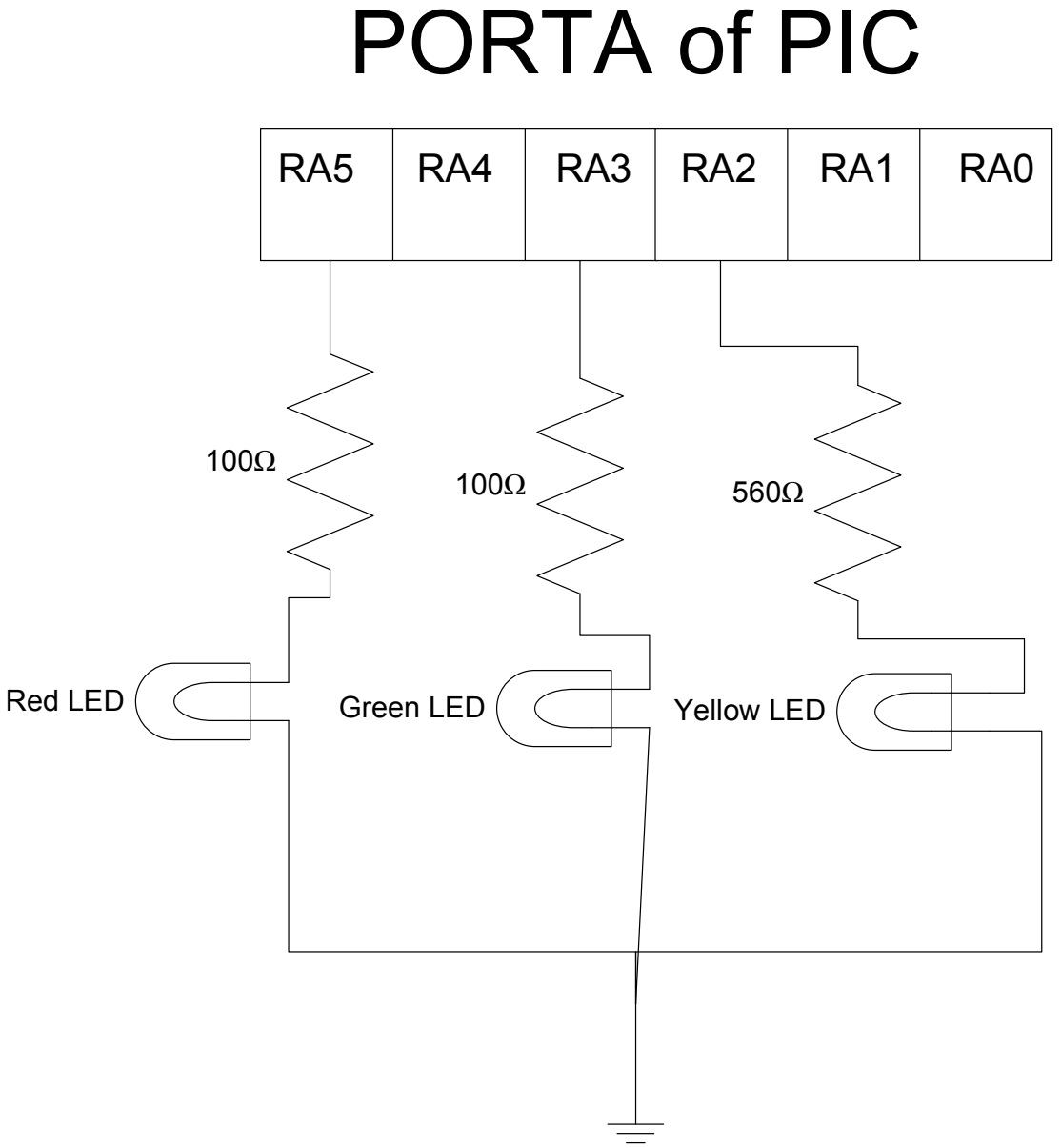
- Picture at left courtesy of Grayhill, Inc. Website: http://lgrws01.grayhill.com/web/images/ProductImages/Series%2096%20Standard%20Keypads.pdf
- Picture above courtesy of Shannon Earley

Keyboard Schematic

PORTC of PIC



LED Schematic



Screen Shots

Project Status

- Reading DEX
  - Done, machine needs servicing
- Encryption / Decryption algorithm
- Functional Keypad, LCD, LED's

Next Semester Tasks

- Convert code to C#
  - Using ARM microprocessor
- Make PCB's for all Hardware
- Enclosure for Hardware
- Vend free beverage
- Provide inventory information

Timeline

Task Name	Start	Finish
Learn C# (Birendra, Shannon, Peter)	Mon 9/1/08	Wed 10/1/08
Encryption in C# (Birendra)	Tue 9/30/08	Fri 10/31/08
DEX Communication (Serial) in C# (Peter)	Tue 9/30/08	Fri 10/31/08
Analyze DEX Data (Peter)	Mon 9/1/08	Wed 10/1/08
Hardware Design in C# (Shannon)	Tue 9/30/08	Fri 10/31/08
Order parts (Birendra, Shannon, Peter)	Mon 9/1/08	Tue 9/23/08
PCB Layout and ordering (Shannon)	Wed 10/15/08	Wed 11/19/08
Integrating C# software (Birendra, Shannon, Peter)	Wed 10/15/08	Fri 11/28/08
Circuit assembly (Shannon)	Mon 9/29/08	Fri 10/31/08
Breadboard circuit with new Micro (Shar	Mon 9/1/08	Tue 9/30/08
Circuit Testing (Shannon)	Wed 10/15/08	Wed 11/19/08
Design Enclosure	Mon 10/27/08	Fri 12/5/08
Internal circuit (Peter)	Mon 10/27/08	Fri 12/5/08
User interface (Shannon)	Mon 10/27/08	Fri 12/5/08
Mounting to machine (Birendra)	Mon 10/27/08	Fri 12/5/08

Budget

Item	Unit Cost	Acquired Cost	Qty	Notes
Pepsi Machine	$ 600.00	$ -	1	Bought by Travis
Main Components				
Microprocessor 1	$ 20.00	$ 40.00	2	ARM needed to implement C# code
Microprocessor 2	$ 8.10	$ 16.20	2	used for receiving data from DEX
20x4 LCD Display	$ 10.00	$ -	1	acquired from Bart
PushButton (illuminated)	$ 3.50	$ 3.50	1	
Keypad	$ 5.00	$ 5.00	1	
Other Components (resistors, caps, op-amps, swirches. etc.)	TBD	$ 15.00	TBD	
Mechanical				
Ribbon Cable (PCB-LCD, Keypad)	$ 3.25	$ 3.25	1	assuming 20 conductors, 5'
Ribbon Cable Connector (to PCB)	$ 2.60	$ 5.20	2	20 pins
DEX connector/adapter	$ 100.00	$ -	1	Got connectors and made cable
Power Connector (from machine pwr)	TBD	TBD		
PCB - final version out of house	$ 50.00	$ 50.00		

Budget Cont'd

Enclosures					
Inner	$	9.73	$	9.73	4.88X6.88X.9 - size TBD
Outer - clear enclosure	$	18.19	$	18.19	6.30X6.30X1.20"
Software					
Visual Studio			$	-	provided by Travis
Other necessary tools					
Development kit (SJJ Embedded Micro Solutions)	$	150.00	$	150.00	1 Will be used when we implement C#
C# Embedded Programming tutorial	$	15.00	$	15.00	Embedded Programming
Totals:	$	995.37	$	331.07	

Summary

- DEX communication
- Encryption
- User Interface